Parametric Study of Flat Slab with Various Loading Types and Panel Aspect Ratio

R. P. Soni [1], Prof D. H. Raval [2]

[1] P.G Student, [2] Assistant Professor
Applied Mechanics Department
L.D. Collage of Engineering, Ahmadabad, India
[1]soniruchik@gmail.com, [2]raval.deepa@gmail.com

***Abstract* - Paper presents analysis of flat slab with drop panel subjected to realistic concentrated loadings – trapezoidal load, line load and patch load. Finite element analysis in software SAFE of rectangular flat slab panels under gravity loads is carried out for the different panel aspect ratio 1, 1.5 and 2. For different panel aspect ratio Positive and Negative moments of column strip and middle strips as well as Punching shear values at critical sections under trapezoidal load, line load and patch load are compared with that under Equivalent Uniformly distributed loads.**

Keywords – Flat Slab, Finite element analysis, Line load, Panel aspect ratio, Patch load, Trapezoidal Load, Surface loads, Punching Shear

I. INTRODUCTION

Flat slabs are highly preferred floor system for large column free areas. Also includes advantages of economy and reduced storey heights. Exact analysis of flat slab is complex and design given by various codes is based on empirical formula and limited to uniformly distributed load only. Therefore finite element analysis is done to carry out to precise analysis under other realistic loading. Flat slab is analysed in SAFE software for panel aspect ratio 1, 1.5 and 2.

II. METHODOLOGY

Flat slab is analysed in software SAFE (Slab Analysis by Finite Element Method) area divided into 5x5 panel system subjected to various gravity load i.e. surface load, trapezoidal load, line load, patch load. Moments of column strip and middle strip are compared with equivalent uniformly distributed load. There are following load cases enlarged.

1. Panels subjected to line load acting along centre lines of the panel on $0.1L_x$ and $0.1L_y$ wide strips.
2. Panels subjected to central patch load size $0.1L_x$ and $0.1L_y$.
3. Trapezoidal load.

In this analysis quadrilateral shell element is used. Results are compared with the same total load acting as uniformly distributed load for the aspect ratio 1, 1.5, 2.

DATA-

Panel Size- vary as per aspect ratio
Column Size- 500mmx500mm
Drop Panel- 3mx3m
Dead Load- 2.7 KN/m^2
Live Load- 2.5 KN/m^2
Grade Used- M20 & Fe 415

2.1 Calculation of Loads Equivalent to Uniformly Distributed Load-

2.1.1 Calculation of Uniformly Distributed Load-

Self weight of slab @ 25 *0.2 = 5.0 KN/m^2

I. Dead load = 2.7 KN/m^2
II. Live load = 2.5 KN/m^2
Total load = 10.2 KN/m^2

Factored load on slab W_u = 10.2 * 1.5 = 15.3 KN/m^2
Where W_u = Total load on slab

2.1.2 Calculation of Trapezoidal Load-

Trapezoidal load is applied on the all the panels of the flat slab on the whole panel area.
W_u = Total surface load on flat slab = 15.3 KN/m^2
Total trapezoidal load on flat slab = (W_u * L * B * 3)/ (B * L)
= (15.3 * L * B)/ (B * 0.1 L)
= 46 KN/m^2

2.1.3 Calculation of Line Load-

Total line load on flat slab = (W_u * L * B)/ (B * 0.1 L)

= (15.3 * L * B)/ (B * 0.1 L)
= 153 KN/m

2.1.4 Calculation of Patch Load-

Total line load on flat slab = (W_u * L * B)/ (0.1 B * 0.1 L)
= (15.3 * L * B)/ (0.1 B * 0.1 L)
= 1530 KN/m^2

III. RESULT

3.1 Comparison of Column Strip Moment for Aspect Ratio 1, 1.5, 2 for each load case-

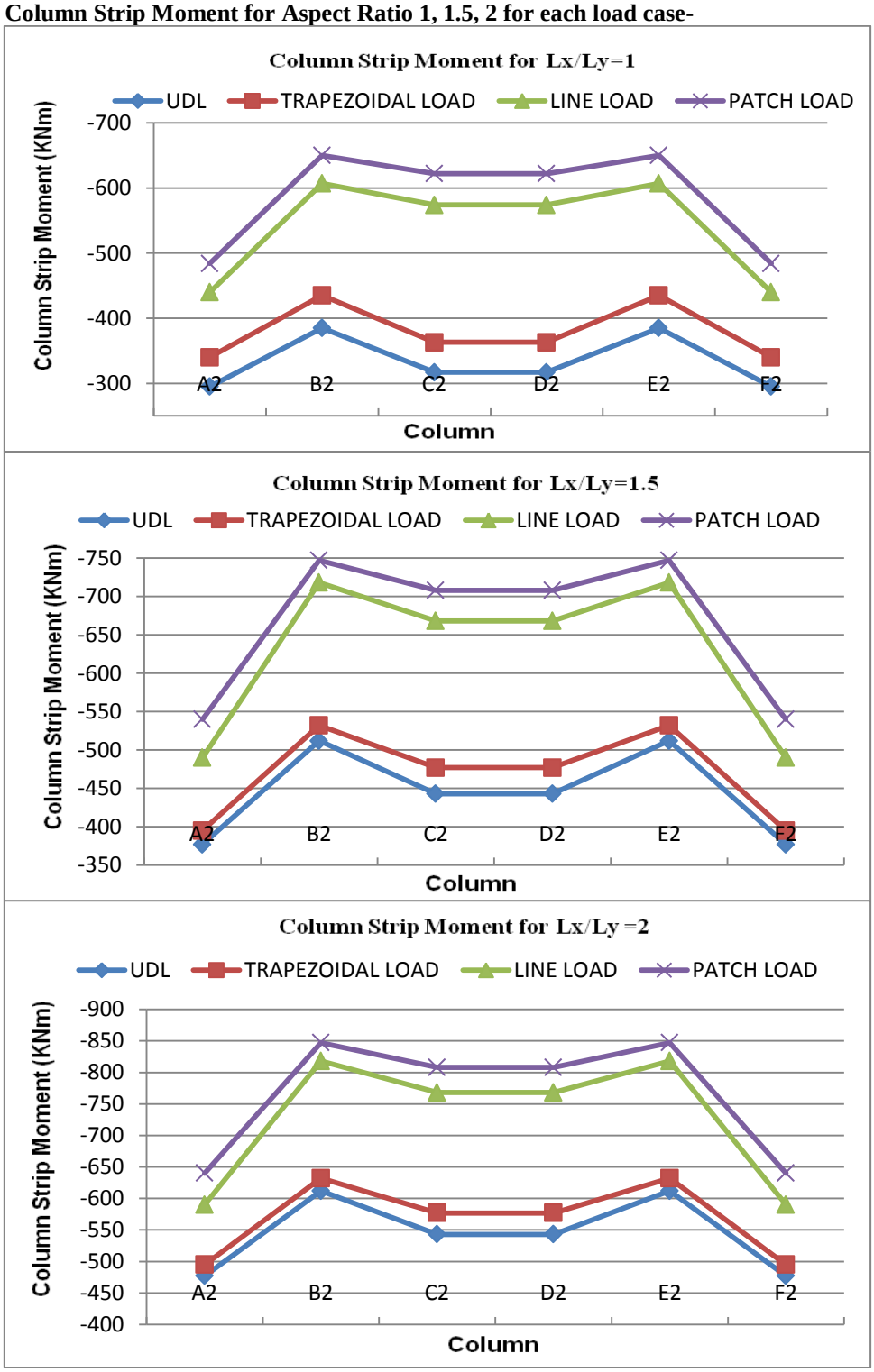

Fig 3.1: Comparison of Column Strip Moment for Each Load Case for Lx/Ly= 1, 1.5, 2

3.2 Punching Shear Force for Aspect Ratio 1, 1.5, 2 for each load case

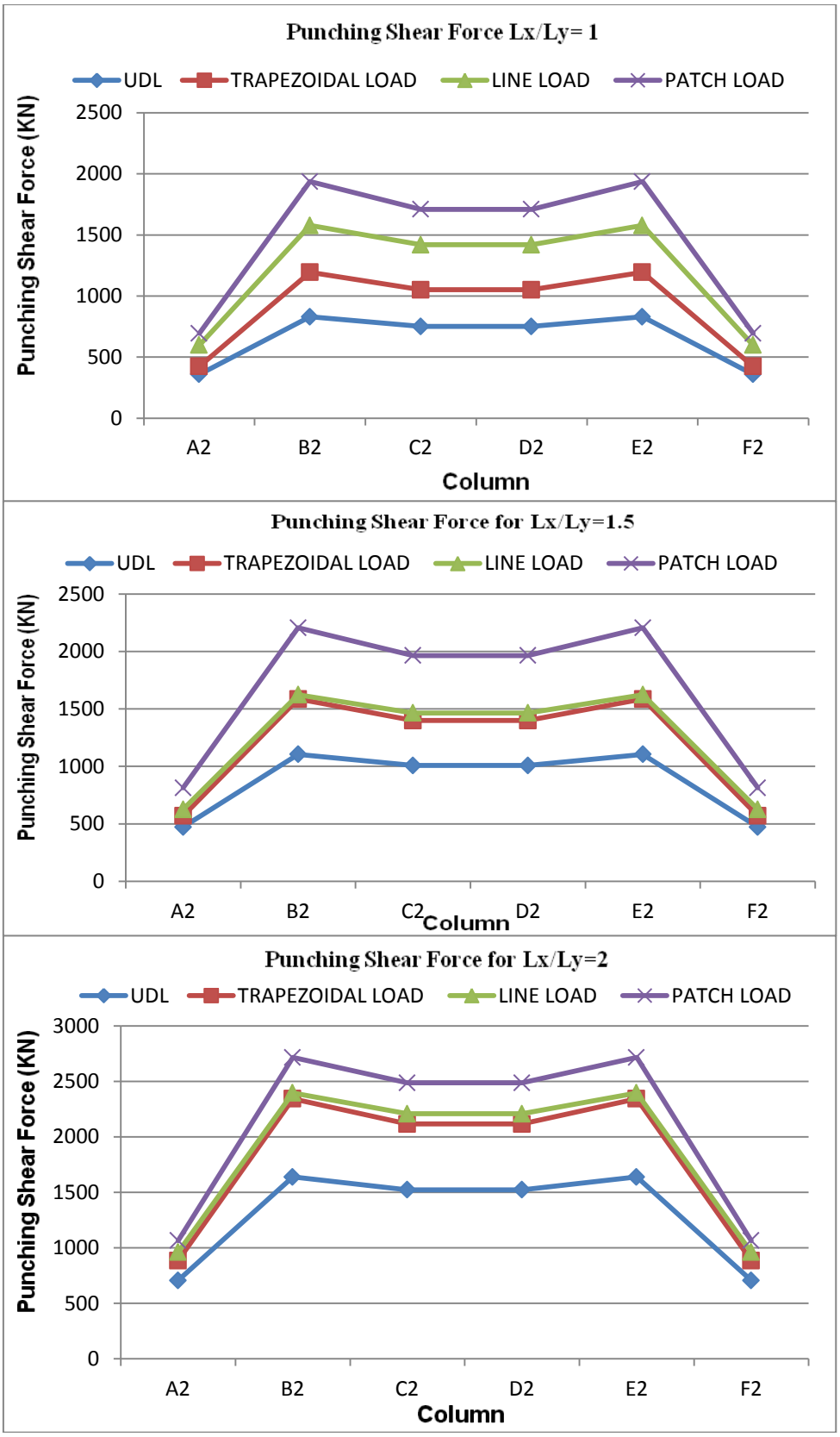

Fig 3.2: Comparison of Punching Shear Force for Each Load Case for Lx/Ly= 1, 1.5, 2

3.3 Comparison of Width of Column Strip for Aspect Ratio 1, 1.5, 2 for each load case-

Width of Column Strip (mm)				
Panel	UDL	TRAPEZOIDAL LOAD	LINE LOAD	PATCH LOAD
A1-F1	2000	2050	2250	2300
A2-F2	4000	4100	4500	4600
A3-F3	4000	4100	4500	4600
A4-F4	4000	4100	4500	4600
A5-F5	4000	4100	4500	4600
A6-F6	2000	2050	2250	2400

Table 3.1: Width of Column Strip Comparison for Each Load Case (L_x/L_y=1)

Width of Column Strip (mm)				
Panel	UDL	TRAPEZOIDAL LOAD	LINE LOAD	PATCH LOAD
A1-F1	2050	2100	2300	2350
A2-F2	4100	4200	4600	4700
A3-F3	4100	4200	4600	4700
A4-F4	4100	4200	4600	4700
A5-F5	4100	4200	4600	4700
A6-F6	2050	2100	2300	2350

Table 3.2: Width of Column Strip Comparison for Each Load Case (L_x/L_y=1.5)

Width of Column Strip (mm)				
Panel	UDL	TRAPEZOIDAL LOAD	LINE LOAD	PATCH LOAD
A1-F1	2100	2150	2350	2450
A2-F2	4200	4300	4700	4900
A3-F3	4200	4300	4700	4900
A4-F4	4200	4300	4700	4900
A5-F5	4200	4300	4700	4900
A6-F6	2100	2150	2350	2450

Table 3.3: Width of Column Strip Comparison for Each Load Case (L_x/L_y=2)

IV. CONCLUSION

- Difference between column strip moment between uniformly distributed load and trapezoidal load is almost more than 50% which goes almost 250% higher (2.5 times) and 5.5 times in case of line load and patch load respectively.
- Thus it can be derived from above study that analysis of flat slab under realistic loading like trapezoidal load, line load, and patch load one cannot relay on codal method but Finite element analysis must to be adopted.
- As the aspect ratio changes from 1 to 2 middle strip moment is increasing 130% for aspect ratio 1.5 (1.3 times) and 165% for aspect ratio 2 (1.6 times) with respect to aspect ratio 1.
- Difference between width of column strip and middle strip for the uniformly distributed load and trapezoidal load is varying less but for line load and patch load is varying very large as the aspect ratio increases.
- Difference between punching shear force between uniformly distributed load and trapezoidal load is almost 130% higher and for line load and patch load it goes 150% and 170% respectively.

REFERNCES

[1] Dan Vasile Bompa and Traian One (2013) "Failure analysis of symmetric flat slab column connection with shear reinforcement."

[2] Lorcan Garrett, John Benson and Kevin Finn (2008) "Comparison of designing of flat slab using finite element analysis with traditional methods."

[3] Patel Jecky R (2012)"Analysis and design of reinforced concrete flat slab using various codes"

[4] Sonawane Sandip Prakash (2008) "Software for analysis and design of flat slab.

[5] Qi Zhang (2004) "Finite element application to slab-column connections reinforced with glass fibre-reinforced polymers."

[6] Design of Reinforced Concrete Structure by H.J.SHAH.

[7] Reinforced Concrete Design by PILLAI and MENON.

[8] Behavior of Reinforced Concrete Flat Slab by P.E.REGON.

[9] IS 456:2000, "Plain and Reinforced Concrete, - Code of Practice", Bureau of Indian Standards, New Delhi.